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ABSTRACT

Biotechnology is the latest in a series of technological innovations that have revolutionized the fields of agriculture and the health sciences; however, there are concerns with this technology. This document is designed to help foster dialogue with emphasis on education and the development of a public understanding of the principals involved in biotechnology research product development and risk analysis. In bibliographical form containing citations which include title, author and source, the National Agriculture Library Call Numbers and key words, sources of information on biotechnology are made available to teachers, university faculty, environmental activists, government regulators, industry representatives and the public who have an interest in biotechnology research, education and training. The first sections of this bibliography deal with general information, manuals and textbooks, and training. Following these sections are specific sections on education at the secondary school and university levels, university and collaborative efforts, and education and training in the international arena. The final sections include education information on specific disciplines that have been impacted greatly by biotechnology including agriculture, medicine, microbiology and mycology, pharmaceutics, plant breeding, and veterinary science. An author index follows the biographic information. (PR)

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Biotechnology: Education

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Diana Airozo
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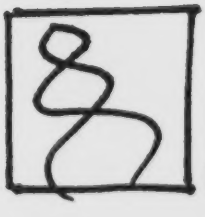
Biotechnology Information Center



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BIOTECHNOLOGY: EDUCATION

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INTRODUCTION

Biotechnology is the latest in a series of technological innovations that have revolutionized the fields of agriculture and the health sciences. Already great strides have been made in applying the techniques of molecular biology and genetic engineering to the problems of disease diagnosis, gene therapy and the development of new pharmaceuticals. In the agricultural industry this technology is being used to address many of the problems associated with the production of food and fiber. These include: plant breeding for disease and pesticide resistance, stress tolerance, and more effective nutrient utilization; energy production from biomass and bioremediation; and animal growth, health, reproduction, and genetics.

Although biotechnology holds great promise for the agricultural and medical sciences, there is concern about the risks, both real and imagined, posed by this technology. For example, two-thirds of the American public are of the opinion that genetically altered bacteria represent a threat to the environment and nearly 50% see a similar risk from genetically altered plants and animals. Questions also exist regarding the safety of foods and food products produced by genetically altered organisms and the possible negative economic effects of these products on the American farmer. Finally there are ethical questions. Public opinion polls repeatedly find that a significant minority of Americans simply believe that genetic manipulation of plants and animals is morally wrong.

These many questions and concerns expressed by the American public highlight the necessity of developing a significant dialogue among all the parties involved. This dialogue must include an emphasis on education and the development of a public understanding of the principals involved in biotechnology research, product development and risk analysis. Only in this context can an interested public work hand-in-hand with industry officials, government regulators and environmental activists in making informed decisions about the development and regulation of this important industry.

To this end, the Biotechnology Information Center at the National Agricultural Library has produced this Special Reference Brief (SRB) in Biotechnology Education. The sources of information cited herein provide a good starting point for teachers, university faculty, environmental activists, government regulators, industry representatives and the public who have an interest in biotechnology research, education and training.

The bibliography has been sub-divided into several sections corresponding to the needs and interests of those involved in biotechnology education. The first sections deal with general information, manuals and textbooks, and training. Following this are specific sections on education at the secondary school and university level; university and industry collaborative efforts; and education and training in the international arena. The final sections include education information on specific disciplines that have been impacted greatly by biotechnology including agriculture, medicine, microbiology and mycology, pharmaceuticals, plant breeding, and veterinary science. An author index follows the bibliographic information.

The citations included in the bibliography were extracted from several major databases including AGRICOLA, Eric, Embase, Current Biotechnology Abstracts and others. In addition to the title, author and source, each citation also includes key words and the National Agricultural Library (NAL) Call Number if the material is part of the NAL collection.

GENERAL INFORMATION

001
"What's a nice biology teacher like you doing teaching humanities?" C.A. Biermann. American Biology Teacher 52(8):487-90(Nov-Dec 1990).
NAL CALL NO: QH1.A43
KEYWORDS: college science, controversial issues (course content), course descriptions, ethics.

002
"Impact of biotechnology on libraries and educational resources." M. Adams et al. American Journal of Pharmaceutical Education 54(1):71(Spr 1990).
KEYWORDS: biomedicine, educational resources, information services, library collections, pharmaceutical education, technological advancement.

003
"Educating the public about biotechnology." H. Kannegiesser. Australian Journal of Biotechnology 4(1):14,17(1990).
NAL CALL NO: TP248.13 A95
KEYWORDS: perception, social impact

004
"Projector center. What Is biotechnology?" B. Belzer and C.L. Case. American Biology Teacher 52(6):376-78(Sep 1990).
NAL CALL NO: QH1.A43
KEYWORDS: college science, food, science and society, science history, secondary school science.

005
"The possible vs. the probable." J.D. Caulder. Bio/technology (USA) 8(1):80(1990).
NAL CALL NO: QH442.B5
KEYWORDS: education and training, teaching, university.

006
"A multidisciplinary course in bioengineering." P.R. Bienkowski et al. Chemical Engineering Education 23(4):204-06(Fall 1989).
KEYWORDS: chemical engineering, college science, course descriptions, course objectives, engineering education, interdisciplinary approach, bioengineering.

007
"Evaluation of an in-service course on biotechnology." R.L. Lock and J. Dunkerton. Research in Science and Technological Education 7(2):171-81(1989).
KEYWORDS: biological sciences, evaluation methods, inservice teacher education, secondary school science, technological advancement.

008
"Biotechnology education." P.E.O. Wymer. AgBiotech News and Information 1(5):687-690(1989).
KEYWORDS: reviews.

009
"Biotechnology teaching gets funds." Biotechnology Newswatch 9(12):2(Jun 1989).
NAL CALL NO: TP248.13 B54
KEYWORDS: education and training, funding and investment.

010
"Biotechnology education programme expands." Chemical and Engineering News 67(18):26(May 1989).
NAL CALL NO: 381 J825N
KEYWORDS: training and education.

011
Reform and Innovation of Science and Education Planning for the 1990 Farm Bill Committee on Agriculture, Nutrition, and Forestry, United States Senate Washington, D.C.: U.S. G.P.O., 1989. 256 pp.
NAL CALL NO: S441.R38
KEYWORDS: agriculture and state, agricultural biotechnology, sustainable agriculture, agriculture research.

012
Biotechnology Education Elmsford, NY: Pergamon Press, c1989.
NAL CALL NO: TP248.2.B546
KEYWORDS: study and teaching - periodicals.

013
"Toward better education in biopolitics." R.H. Blank et al. Issues in Science and Technology 4(3):51-53(Spr 1988).
NAL CALL NO: Q225 I7
KEYWORDS: biology, college science, core curriculum,, science and society, technology, social issues.

014
"Biotechnology enters vocational agriculture." R.A. Martin. Vocational Education Journal 63(4):36-38(May 1988).
KEYWORDS: advisory committees, agricultural education, curriculum development, vocational education.

015
Educational Bridges to Options in High Technology Employment. Final Report San Diego State Univ.,Calif. Sponsoring Agency: Fund for the Improvement of Postsecondary Education, Washington, D.C., 1988. 32 pp.
KEYWORDS: biological sciences, labor force development, physical sciences, retraining, technology.

016
"Science professional training program in tissue culture and biotechnology." W.D. Graziadei. In: Forest and Crop Biotechnology: Progress and Prospects; Colloquium, Syracuse, NY, April 18-20, 1985 ed F.A. Valentine. New York, NY: Springer-Verlag, 1988. pp . 423-424.
NAL CALL NO: S494.5 B563F67
KEYWORDS: general biology, textbooks, methods and media, audio-visual aids.

017
Research Priorities and Factors Affecting Research in Agricultural Education in the United States L.F. Silva-Guerrero. Thesis, Cornell University, 1988. 220 pp. (Available from University Microfilms, Inc.).
KEYWORDS: universities, attitudes, surveys.

018
"Expanding the horizons for biotechnology education." L. Seenath. Trends in Biotechnology 6(6):108-110(1988).
NAL CALL NO: TA166.T72
KEYWORDS: general biology, textbooks, audio-visual aids.

019
"Biotechnology and its future: implications for school and careers." J. Frey and J. Cronn. Journal of the Minnesota Academy of Science 53(1):40-42(Fall 1987).
NAL CALL NO: 500 M663
KEYWORDS: universities, students, career development.

020
"Social and legal issues of biotechnology: An educational perspective." C.P. Hodgson. Ohio Journal of Science 87(5)148-53(Dec 1987).
NAL CALL NO: 410 OH3
KEYWORDS: biology, ethics, genetic engineering, patents, research universities, technological advancement.

021
"The impact of biotechnology on school teaching." L. Josefsson. Biochemical Education 15(4):177-79(Oct 1987).
NAL CALL NO: QD415 A1B53
KEYWORDS: biochemistry, foreign countries, high schools, science curriculum, secondary school science, teacher education.

022
"Biotechnology in the schoolroom." New Scientist (1569):67-68(Jul 1987).
NAL CALL NO: 472 N42
KEYWORDS: education and training.

023
"Public domain programs for teaching biotechnology." H.R. Bungay. Abstract Paper American Chemical Society National Meeting, New Orleans, LA, August 30 - September 4, 1987 194(0)(1987).
KEYWORDS: computers, biochemical engineering.

024
Education for Biotechnology B.F. Rinard. Waco, Tex.: Center for Occupational Research and Development, c1986. 43 pp.
NAL CALL NO: TP248.2.R56
KEYWORDS: study and teaching, curricula.

025
"Food for thought." J.W. Kotrlik, G. Parton, and C. Borne. The Agricultural Education Magazine 59(3):9-10(Sept 1986).
NAL CALL NO: 275.8 AG8
KEYWORDS: agricultural education, vocational training, technology, innovations.

026
"Shift your gears--to high technology." G. Raymond and K.E. Nowels. The Agricultural Education Magazine 59(3):5-6(Sept 1986).
NAL CALL NO: 275.8 AG8
KEYWORDS: agricultural education, technology, telecommunications, genetic engineering, vocational training.

027
"The use of simple models in the teaching of genetic engineering." D.S.T. Nicholl. Journal of Biological Education 20(1):12-14(Spr 1986).
KEYWORDS: biology, botany, genetic engineering, science activities, science instruction, secondary school science.

028
A Model Curriculum for Training Biotechnicians R. Thomson. Paper presented at the Annual Convention of the American Vocational Association (Dallas, TX, December 7, 1986). 22 pp.
KEYWORDS: curriculum development, educational needs, futures (of society), paraprofessional personnel.

029
"Biological technology and biological education." A.N. Rao and R.A. Kille. In: Biological Technology and Biological Education eds A.N. Rao and R.A. Kille Hamburg, West Germany: Commission for Biological Education, 1986. 155 pp.
KEYWORDS: book reviews.

030
"Where does biotechnology fit in teaching biology?" J.N. Reeve. Ohio Journal of Science 86(2):29(1986).
NAL CALL NO: 410 OH3
KEYWORDS: abstract, conference paper.

031
"A symposium: biotechnology and its implications for education." S.E. Reames. Ohio Journal of Science 86(2):28(1986).
NAL CALL NO: 410 OH3
KEYWORDS: abstract.

032
"EXPERFARM: A new package in BASIC for teaching genetics." E. Santiago and M.A. Comendador. Comput. Appl. Biosci.(England) 2(1):29-32(1986).
KEYWORDS: genetics, computer program, computer simulation, teaching.

033
"Bioengineering education, 1986 - Part I." P.A. Browneller. J. Clin. Eng. 11(1):39-54(1986).

034
"Computer-aided education and computer programmes in biotechnology." P. Peringer. Swiss Biotech 4(4):15-20(1986).
KEYWORDS: computer application, education and training.

035
"Biotechnology takes its place in schools." New Scientist 111(1522):26(Aug 1986).
NAL CALL NO: 472 N42
KEYWORDS: fermenter, mini; education and training.

036
"Biotechnology and schools." R.F. Hornblower. Intl. Ind. Biotechnol. 6(5):145-147(Aug/Sep 1986).
KEYWORDS: education and training, review.

GENERAL MANUALS/TEXTBOOKS

037
Biology: A Journey into Life 2d ed. K. Arms and P.S. Camp. Philadelphia, PA: Saunders College Publishing, 1991. 833 pp.
KEYWORDS: genetics, evolution, animal biology, plant biology, ecology, molecular biology.

038
Applied Genetics G. Hayward. Basingstoke, UK: Macmillan, 1990. 229 pp.
KEYWORDS: applied genetics, genetic engineering.

039
"A user-friendly method for teaching restriction enzyme mapping." R. Ehrman. American Biology Teacher 52(7):429-35(Oct 1990).
NAL CALL NO: QH1.A43
KEYWORDS: college science, enzymes, genetics, laboratory procedures.

040
"A CAL Program to teach the basic principles of genetic engineering--A change from the traditional approach." D.G. Dewhurst et al. Journal of Biological Education 23(3):218-22(Fall 1989).
KEYWORDS: computer assisted instruction, computer software reviews, genetic engineering.

041
Biotechnology Abstracts Online Users Manual 4th ed. London: Derwent Publications, c1989. 71 pp.
NAL CALL NO: Z699.35.O55B5 1989
KEYWORDS: online bibliographic searching, catalogs, online user education, database searching.

042
"Biotechnology laboratory methods." R.H. Davis and D.S. Kompala. Chemical Engineering Education 23(3):182-87(Sum 1989).
KEYWORDS: chemical engineering, college science, course content, engineering education.

043
Plant Genetic Transformation and Gene Expression: a Laboratory Manual eds. J. Draper, R. Scott, P. Amritage, and R. Walden. Oxford, UK: Blackwell Scientific Publications, 1988. 355 pp.
NAL CALL NO: QK981.5 P58
KEYWORDS: genetic transformation, gene expression.

044
"How-to-do-it: Biotechnology in three days." A.M. Gardner. American Biology Teacher 50(7):446-48(Oct 1988).
KEYWORDS: DNA, genetics, science instruction, secondary school science.

045
"How-to-do-it: Recombinant DNA made easy: I. 'Jumping Genes.'" R.G. Thomson. American Biology Teacher 50(2):101-06(Feb 1988).
KEYWORDS: college science, genetics, laboratory procedures, microbiology.

046
Decisions for Today and Tomorrow: Student Guide. Issues in Science-Technology-Society. A Multidisciplinary Approach to Problem-Solving and Critical-Thinking L.A. Iozzi and P.J. Bastardo. Salt Lake City, UT: National Energy Foundation, 1987. 186 pp.
KEYWORDS: environmental education, genetic engineering, science and society, secondary school education.

047
Decisions for Today and Tomorrow: Teaching Notes. Issues in Science-Technology-Society L.A. Iozzi and P.J. Bastardo. Salt Lake City, UT: National Energy Foundation, 1987. 45 pp.
KEYWORDS: environmental education, genetic engineering, science and society, secondary school education.

048
Biotechnology: A Comprehensive Treatise in 8 Volumes eds. H.J. Rehm and G. Reed. New York: VCH Publishers, Inc.
NAL CALL NO: QR53 B52

049
Basic Biotechnology. A Student's Guide eds. P. Prave, U. Faust, W. Sittig, and D.A. Sukatsch. Weinheim, German Federal Republic: VCH Verlagsgesellschaft mbH, 1987. 344 pp.
KEYWORDS: microbiology, biotechnology.

050
An Introduction to Genetic Analysis D.T. Suzuki, A.J.F. Griffiths, J.H. Miller, and R.C. Lewontin. New York: W.H. Freeman and Company, 1986. 612 pp.
KEYWORDS: genetics.

051
Manipulating the Mouse Embryo. A Laboratory Manual B. Hogan, F. Costantini, and E. Lacy, USA: Cold Spring Harbor Laboratory, 1986. 232 pp.
NAL CALL NO: QL959 H74
KEYWORDS: genetic engineering, laboratory manual, mice.

TRAINING

052
"A TAFE strategy for biotechnology skills training." R. Stark. Australian Journal of Biotechnology 4(1):69-73(Jan 1990).
NAL CALL NO: TP248.13 A95
KEYWORDS: training.

053
"More biotechnology training support urged." Chemical and Engineering News 68(8):15(Feb 1990).
NAL CALL NO: 381 J825N
KEYWORDS: training, funding, investment.

054
"COBIOTECH:another international committee?" K.C.A.M. Luyben. EFB Newsl (15):222(June 1989).
KEYWORDS: training, legislation.

055
"Manpower and training needs for biotechnology." P.N. Campbell. Biotechnology and Applied Biochemistry (USA) 11(6):525-526(1989).
NAL CALL NO: QD415.A1J63
KEYWORDS:biotechnology, training.

056
Training for Employment in Biotechnology: an Evaluation of the SERC Biotechnology Directorate's Training Awards Policies
R.K. Waite, R. Pearson, and G. Pike. Swindon, UK: Science and Engineering Research Council, 1989. viii, pp. 186.
KEYWORDS: training, biotechnology.

057
Manpower, Education, and Training in Biotechnology D.J. Bennett. London: Association for the Advancement of British Biotechnology, 1988. 32 pp.
KEYWORDS: training.

058
"Development of training programs in biotechnology safety and risk assessment." S. Riazuddin. Bioessays 9(4):131-132(1988).
NAL CALL NO: QH506 B356
KEYWORDS: recombinant DNA, genetic engineering, safety.

059
"Research and training activities of the European Communities in biotechnology." D. de Nettancourt. In: First Forum for Applied Biotechnology, Part I, October 1, 1987 part A, pp.1343-1348.
KEYWORDS: programs, industry.

SECONDARY SCHOOL LEVEL

060
"Introducing applications of biotechnology to high school students." D.L. Wise et al. Chemical Engineering Education 24(3):158-62(Sum 1990).
KEYWORDS: biological sciences, course descriptions.

061
"Are high school students ready for recombinant DNA?: The UOP experience." M.J. Minch. Journal of Chemical Education 66(1):64-65(Jan 1989).
NAL CALL NO: 381 J826
KEYWORDS: academically gifted, biochemistry, college science, course descriptions, genetic engineering, secondary school students.

062
"How-to-do-it: Teaching recombinant DNA technology in high school biology courses." L. Dixon. American Biology Teacher 50(6):368-73(Sep 1988).
KEYWORDS: biology, DNA, experiential learning, laboratory experiments, science and society, secondary school science.

063
"How-to-do-it: Recombinant DNA technology in the high school biology laboratory." R. Myers. American Biology Teacher 50(1):43-45(Jan 1988).
KEYWORDS: genetics, laboratory procedures, science activities, secondary school science, technology, cloning.

064
"Biotechnology 13-18: In-Service training for teachers." C. Gayford. Journal of Biological Education 21(4):281-87 (Win 1987).
KEYWORDS: biological sciences, course descriptions, inservice teacher education, science and society, teacher improvement, technology.

065
"Biotechnology in high school: research for tomorrow?" P.B.J. Burton. Trends in Biotechnology 5(11):293-294(Nov 1987).
NAL CALL NO: TA166.T72
KEYWORDS: education and training.

066
"The consistency of the opinions of 12th-Grade biology pupils on the desirability of biotechnologies." A. Dreyfus and Z. Roth. Research in Science and Technological Education 4(2):139-52 (1986).
KEYWORDS: biology, controversial issues (course content), science and society, secondary school science, student attitudes, science education research.

UNIVERSITY LEVEL

067
"Integrating biotechnology into a graduate program in plant breeding: A graduate student's perspective." L. Marshall. Journal of Agronomic Education 19(2):211-214(1990).
NAL CALL NO: S530.J6
KEYWORDS: human, agriculture, genetics.

068
"Teaching microbial ecology and applied microbiology at small colleges and universities." D.K. Brannan and N.A. Key. Annual Meeting of the American Society for Microbiology, Anaheim, CA, May 13-17, 1990 90:439(1990).
KEYWORDS: abstract, human, industrial, genetic engineering.

069
"Expectations of the graduate student." D.M. Bubeck. Journal of Agronomic Education 19(2):215-218(1990).
NAL CALL NO: S530.J6
KEYWORDS: plant breeding program, agriculture, genetics.

070
"Farm kids grab future in biotech." D. Seim. Farm Journal 112 (10):34-35(Aug 1988).
NAL CALL NO: 6 F2212
KEYWORDS: agricultural colleges, college programs, outside finance, private companies, rural youth, students.

071
"Biotechnology at the University of Toledo: Development and implementation of an integrated curriculum." R.A. Hudson. American Journal of Pharmaceutical Education 52(4):355-57(Win 1988).
KEYWORDS: biochemistry, curriculum design, pharmaceutical education, undergraduate study.

072
"Recombinant DNA technology. A topics course for undergraduates." K.A. Parson. Journal of Chemical Education 65(4):325-26(Apr 1988).
NAL CALL NO: 381 J826
KEYWORDS: biochemistry, biological sciences, college science, course descriptions, DNA, science instruction.

073
"Undergraduate education in biotechnology." T.H. Carter. Bio-TECHNOLOGY (New York) 5(4):347-349(1987).
KEYWORDS: general biology, textbooks.

UNIVERSITY/INDUSTRY COLLABORATION

074
"Land-grant university-industry relationships in biotechnology: a comparison with the non-land-grant research universities." J. Curry and M. Kenney. Rural Sociology 55(1):44-57(Spring 1990).
NAL CALL NO: 281.28 R88
KEYWORDS: agricultural colleges, industry, research institutes, college programs, educational resources.

075
"Technology transfer from university to industry: Responsive and responsible university policy." A. Wright. Research Management Review 3(1):17-31(Spr 1989).
KEYWORDS: research administration, school business relationship, school policy, social responsibility, technology transfer.

076
"Interfacing biotech in industry and universities." D.A Smith. Genome 31(2):1123-1124(1989).
NAL CALL NO: QH 431.G452
KEYWORDS: conference paper, biotechnology heredity, genetic engineering.

077
"Low-input/sustainable agricultural research and education: challenges to the agricultural economics profession." P. Madden. American Journal of Agricultural Economics 70(5):1167-1172(Dec 1988).
NAL CALL NO: 280.8 J822
KEYWORDS: farm inputs, alternative farming, sustained yield management, research, educational programs, agricultural economics, farm management.

078
"Institutions and scholars face ethical dilemmas over pursuit of research with commercial value." K.S. Mangan. Chronicle of Higher Education 33(46):11-12(Jul 1987).
AL CALL NO: LB2300 C5
KEYWORDS: college faculty, ethics, inventions, technology transfer.

079
"University-industry research relationships in biotechnology: implications for the university." D. Blumenthal et al. Science 232(4756):1361-66(Jun 1986).
NAL CALL NO: 470 SCI2
KEYWORDS: financial support, industry, scientists, technological advancement.

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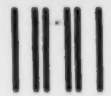

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